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Experiments with various plants to produce change of sex in the individual*

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The writer has had a number of plants under observation and has been experimenting with others which have shown behaviors that tend to throw further light on the problem of the nature of sexuality. It is probable that the problem of sex can only be solved by the accumulation of data from many sources which when finally put together may give such evidence as will lead to the ultimate cause and nature of the remarkable sexual dimorphism exhibited by most living things.

THALICTRUM DIOICUM L.

In the spring of 1921, ten pure carpellate and ten pure staminate plants were dug up and planted in ordinary soil in shallow benches in the greenhouse, thus taking them out of their periodic environment of heat and cold and seasons of moisture and dryness. They were given little attention, except to keep conditions as unfavorable as possible without causing death. Most of these plants bloomed several times during the fall and winter of 1921–22 and also in 1922–23. No change in sex was noted but in the meantime nearly all became decrepit and began to die. By December 1923, only three carpellate plants were still alive and all the staminate had died. One of the survivors developed a small inflorescence which was examined December 3. It contained nine stamens distributed in various, otherwise carpellate flowers. One of the flowers, however, had two stamens. The

* Papers from the Department of Botany, The Ohio State University, no. 154.

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stamens were of varying degrees of perfection. Some had pollen sacs with pollen, but apparently none had perfect pollen. In this decidedly dioecious perennial species, therefore, it required more than two years to induce a change in the sexual condition of the individual, but, nevertheless, one carpellate plant out of ten which had passed through a number of reproductive periods in a purely female condition reversed this condition in nine of its sporophylls so that male characters developed. Evidently the originally determined female state was of a very intense and persistent character, and was only gradually overcome by the decided change in its metabolic processes under the unusual adverse environment. This plant and the other two surviving individuals died, with no further development of flowers, in the winter of 1924. The conditions should have been kept a little more favorable for growth.

In the spring of 1922, a carpellate plant which showed some stamens was transplanted from the woods to a pot in the greenhouse and well fertilized with cow manure. The behavior of this plant was reported in 1923 in "Observations on the Sexual State of Various Plants"* and its record up to date is as follows: In September 1922, the plant bloomed again, producing 14 stamens: one flower having three stamens, some two, and some one. In November of the same year, it bloomed, again with a few stamens. In January 1923, it bloomed once more and this time only carpellate flowers were produced, thus showing a pure female state. The intermediate, bisporangiate, or intersex condition had been changed to a pure female state. By the end of March it was again in anthesis with only pure carpellate flowers. In the meantime the plant was kept richly supplied with manure and water. At the next blooming period, May 11, 1924, the plant was still pure carpellate and the same condition was continued when it bloomed again on June 15 and also on July 20. The plant was neglected during August, but on September 8 it was coming into bloom with a considerable number of flowers, this time producing, among the pure carpellate flowers, four intermediate flowers, each with a single, imperfect stamen. The next blooming period showed a small inflorescence, on November 25, 1924, with all the flowers pure carpellate.

* Schaffner, John H. Ohio Jour. Sci. 23: 155.

It is evident, therefore, that labeling a *Thalictrum dioicum* indivdual at any blooming period as being a pure male or a pure female and thinking to find it so at a future date is a waste of energy, especially if there is very much possibility of change in its environment. Yet, in spite of the fact that occasionally one can find an individual of this species with practically all the flowers bisporangiate, there seems to be a fixedness about the monosporangiate condition which is not easily overcome. This condition, whatever it may be, seems to be the same as that which is developed in the gametophytes of all higher plants, where the given sexual state is handed over from the sporophyte without change and without in the least being disturbed by the reduction divisions. The sex of the gametophyte is but rarely reversed or changed from the state predetermined for it in the sporophyte. Such sporophytes as those of *Thalictrum dioicum*, with strongly fixed sexual states are, therefore, in marked contrast to those of *Thalictrum dasycarpum* F. & L., *Arisaema triphyllum* (L.) Nutt., and *Arisaema dracontium* (L.) Schott, where the sexual condition is so lightly established in the individual that its partial or complete reversal is a comparatively easy matter. Incidentally, the fact must not be overlooked that the intermediate plant described above with a single, vernal blooming period in its normal habitat, under the imposed conditions, actually bloomed five separate times in 1924, strung along from May 11 to November 25. Those who have a wooden notion about the hereditary nature of such ecological or physiological characters will need to re-examine the foundation on which they are standing.

Cannabis sativa L.

During the spring of 1924, an unusually interesting case of sex reversal occurred in connection with some rejuvenation experiments, in a carpellate hemp plant. Some hemp seed was planted on January 16, 1924, and, as the result of developing in the short-light period of winter, came into bloom in a little over a month, the staminate first and the carpellate somewhat later. When the carpellate plants were beginning to show their age, but before sex reversal had appeared in very many of them, they were rejuvenated, beginning March 21, by receiving at night, in addition to the available daylight, the light from two 110-watt mazda

electric bulbs. The special individual under consideration was at this time 10 inches high, was pure carpellate, and was producing seed. The tip of the plant was too senile to undergo rejuvenation, but six branches developed from the lower part and began a vigorous growth, showing the usual series of leaf forms that appear in the seedling or in a rejuvenated stem. One of the most vigorous shoots, when it was about 6 inches long, began to bloom and produced twelve flowers. These flowers were all pure staminate and because of the favorable light were all perfectly typical in character, exactly like the summer flowers of pure staminate plants! There was not a vestige of femaleness about them. Because of the continuous light, which should have kept them from blooming in the first place, the plant was soon thrown back completely into the vegetative condition again. On June 5, the electric light was turned off and the rejuvenated plant grew to be large and vigorous, some of the branches being 6 feet tall. On September 8, on returning from a trip to Kansas, the entire plant, including the large branch that had produced the staminate flowers, was in full bloom and all the flowers were pure carpellate again. On September 9, the plant, because of inconvenient size, was severely pruned and rejuvenated again by means of continuous light, daylight in the daytime and electric light at night. As discovered later, this pruning was improperly done, and resulted in the final death of the entire plant. By September 20, numerous buds were developing which later made a good growth. These shoots were so numerous that many were removed and the plant then took on a more vigorous growth. The electric light was discontinued on December 1, and by December 13 the plant began to die. It had, however, produced a considerable number of incipient flowers, an examination of which showed well-developed stigmas. At this fourth blooming period the plant was apparently again pure carpellate, but if death had not cut the blooming period short, it might still have developed some sex reversal, as was rather to be expected for the season of the year. It is now clear to the writer, from this and other experiments, that hemp will endure considerable pruning and cutting back of the active growing tops, but if the entire plant is cut off at or below the part still bearing leaves, or if any large branches are removed, death is almost sure to follow, the destruction gradually passing down the stem until the tissue is reached that is supporting the growing branches.

Here was a carpellate plant, originally pure female in both vegetative and reproductive expression, which developed in a later reproductive period a pure male expression, and at a still later period pure female expression again. The cell lineage, which was originally in the female state, showed reversal to maleness and then re-reversal to femaleness again. These reversals in zones of growth are similar to the zonal successions and reversals shown by many monoecious plants, with this important difference, however. While a monoecious plant has a neutral vegetative growth and the first sexual state appears in this neutral tissue, the carpellate hemp plant was, as its vegetative character showed, at first in the female state, from the time of the embryonic development until it was rejuvenated. The behavior of this carpellate plant suggests some definite methods of procedure to produce similar results. No flowers should have appeared during the vigorous vegetative growth after rejuvenation and the continuous light should also check sex reversal under normal conditions. Now the writer has shown that in experiments on sex reversal of carpellate hemp plants, a considerable number of individuals show no reversal to maleness until they are becoming very senile, often not until it finally occurs in branches coming from very decrepit stems. In general, the tendency in both staminate and carpellate plants under short light conditions is toward maleness. Staminate plants usually show reversal to femaleness most decidedly at the very beginning of the blooming period, while carpellate plants, as stated, often show no reversal to maleness until extreme old age. In the ordinary annual development there appears to be an up and down gradient, and it is on the down grade of functional activity toward a low functional condition that with a suitable environment a proper state develops for reversal to maleness. Now assuming that the given plant was in a very low vegetative condition and a very decrepit state of senility, as it actually appeared to be at the first rejuvenation, the rejuvenation process would begin a reverse gradient of physiological states becoming more and more normal, and the condition would be passed through in which hereditary factors of anthesis become active, but the senile or other condition which precedes the development of a male state was also attained at this point, in the up grade toward a normal vegetative condition, so the plant not only bloomed but was

thrown completely into a typical male expression, which lasted until the normal vegetative state was attained again. A method should, therefore, be possible by which this same result could be duplicated at will in a certain percentage of cases.

Another point, which presents itself to the writer in an example like the present one, is that such cases of re-reversal answer fully the contention of some who are inclined to interpret simple reversals as cases of abnormal chromosome or factor shiftings or displacements. Such explanations are not only contrary to the evidence in simple reversals, but become ridiculous in the case of double reversals. In view of the fact that exactly similar back and forth reversals take place in many known cases, as for instance in the diploid, parthenogenetic cycle of *Leontodon*, reported by Sears* and others, and in the haploid, parthenogenetic cycle of *Datura*, as reported by Blakeslee and Belling,† it seems to the writer that any supposition except a physiological basis for sexuality is entirely unreasonable.

McPhee‡ obtained complete sex reversal in two staminate plants which were apparently pure staminate at first and later in their lives produced nothing but carpellate flowers and matured seeds. Such cases might give interesting results with several successive rejuvenations. The writer has noted such individual deviations from the more typical behavior of femaleness to maleness and in his "Sex Reversal in the Japanese Hop" said that "In hemp the general tendency appears in age to be towards maleness in both staminate and carpellate plants, although some individuals are exceptional in this respect."§ McPhee obtained in general much lower percentages of reversal than the writer, which may have been due to a number of causes, as not keeping the plants alive long enough, too poor soil, etc.

McPhee apparently has a rather confused notion of what constitutes "sex reversal," a confusion probably arising from reasoning from determinate higher animals with a single develop-

* Sears, Paul B. Amiotic parthenogenesis in *Taraxacum vulgare* (Lam.) Schrk. and *Taraxacum laevigatum* (Willd.) DC. Ohio Jour. Sci. **17:** 97–100. 1917.

† Blakeslee, Albert F., and Belling, John. Chromosomal mutations in the Jimson weed, *Datura stramonium*. Jour. Hered. **15:** 195–206. 1924.

‡ McPhee, Hugh C. The influence of environment on sex in hemp, *Cannabis sativa* L. Jour. Agr. Res. **28:** 1067–1080. 1924.

§ Bull. Torrey Club. **50:** 75. 1923.

mental period. The sex reversal is genetically and physiologically the same whether it is accomplished in the plumule and continues for an indefinite period (which would then be a "true" sex reversal according to McPhee, because no intersexuality would be present) or whether it takes place in a single flower-bud or in a single sporophyll (which would not be sex reversal according to McPhee). If we are to discuss the intricate problem of sexuality in plants intelligently, we evidently need to have some considerable knowledge of the morphology, physiology, and general nature of plants.

McPhee has not at all given a correct notion of the evidence published by the writer when he says: "It is true that Schaffner has obtained as high as 88 per cent of "sex reversal" in one plat which was grown in the greenhouse during the short days of winter, but when we consider that the plat contained only 16 plants, we must be careful in drawing the conclusion that the same percentage of plants in a much larger plat would show the same change." How any one could get such a notion from my two main papers on hemp cited by McPhee is beyond comprehension! In plain tables among other high records are the following:

Plat 1,	18 carpellate plants—reversed	16.
Plat 2,	36 carpellate plants—reversed	32.
Plat 3,	29 carpellate plants—reversed	25.
Plat 4,	116 staminate plants—reversed	104.
Plat 5,	66 staminate plants—reversed	62.
Plat 6,	42 staminate plants—reversed	39.
Plat 7,	30 staminate plants—reversed	27.

So there is plenty of evidence to show that the writer's conclusion was correct that one could predict 90% or more of sex-reversal by employing the proper methods. It is so simple and easy that one with the merest knowledge of how to grow plants can do it.

Morus alba L.

A number of years ago the writer reported a very striking case of sex reversal in the white mulberry.* A staminate tree had reversed a large branch to a partly female condition, so that

* Schaffner, John H. The nature of the diecious condition in *Morus alba* and *Salix amygdaloides*. Ohio Jour. Sci. **19**: 409-416. 1919.

the branch in question produced not only carpellate catkins and catkins partly carpellate and partly staminate, but also continued to produce pure staminate catkins commingled with the other two types. Although no self-pollination was attempted, it is probable, from the fact that no staminate trees were near this special individual, that the abundant fruit produced was largely self-pollinated. However this may have been, the seed produced was plainly the offspring of two originally staminate parents. A considerable number of seedlings were grown, twelve of which were saved and planted in the garden near the botanical greenhouse on the Ohio State University Campus. Ten of these trees survived and developed to maturity. In the spring of their first blooming period, 1922, a severe frost occurred when the flowers were beginning to expand, which destroyed the entire crop and no study could therefore be made of the sexual conditions of the plants. In 1923, all the ten surviving trees bloomed and were studied in detail. There were seven carpellate individuals and three staminate individuals, and all appeared pure as to sex in the early part of the blooming period. But continued studies showed that toward the end of the blooming period some individuals were intermediate in sexual expression. Two carpellate plants each developed a partial staminate condition. On one catkin there was a staminate flower with four pollen-shedding stamens and some unopened stamens at the base of the catkin. The tip of the catkin was normally carpellate. The other tree also showed a number of staminate flowers more or less perfect in condition. One of the staminate trees produced two catkins with a slight development of femaleness, having enlarged ovularies and reduced stamens. These catkins showed the usual carpellate character in the tardiness of the development of the abscission layers. In 1924, all of the ten trees bloomed again, the seven carpellate individuals being all pure carpellate and the three staminate individuals all pure staminate. No reversal whatever was found, although the plants were studied very carefully.

This experiment, so far as it goes, shows that Yampolsky's* finding for *Mercurialis annua*, where reversed, self-pollinated staminate individuals tended to reproduce maleness, and re-

* Yampolsky, Cecil. Inheritance of sex in *Mercurialis annua*. Am. Jour. Bot. **6**: 410–442. 1919.

versed, selfed carpellate individuals, tended to reproduce femaleness in their offspring, may be only a special case and not of general application. For, as stated, of the ten seedlings from the originally staminate mother parent, seven were female in expression. It is probable that in many cases Yampolsky's findings would hold, for it appears that the original sex condition of the individual which has reversed the special branches or flowers should be more readily established again in the parasitic embryos and that this condition would tend to be continued or intensified up to maturity. But if sex is not primarily determined by specific hereditary factors we would expect the rule to work one way about as often as the other. But my material is too incomplete for speculation. In the spring of 1924, a staminate tree near the Botany-Zoology building of the Ohio State University showed signs of sex reversal on several small branches. Two of these branches were promptly covered with cloth with some staminate catkins included to insure self-pollination. Several self-pollinated fruits were thus obtained, from which 55 seedlings sprouted and are at present growing well in the botanical greenhouse. In several years, therefore, a good number of these plants should be available for study, and settle definitely the problem in so far as the male condition is concerned. To obtain selfed seed from carpellate plants will not be so easy, since usually by the time staminate reversals are discovered, pollination from outside sources may already have taken place. Nevertheless, there are often very isolated trees in country districts, and where such are known, selfed seed should be readily obtained if proper precautions are taken. The writer has known such trees, but never in places available to him for study at the proper time. Any one who is in a position to obtain selfed seed from a carpellate white mulberry should by all means do so.

The question arises as to the possible parthenogenetic development of the white mulberry. But in view of the fact that Tahara* found 14 haploid and 28 diploid chromosomes in *Morus indica* L. and also 28 diploid chromosomes in *M. alba*, the life cycle is probably normal. Nevertheless it would be desirable to have the gametophytic number definitely established. If this has been done it is not known to the writer. Triploid mu-

* Tahara, Masato. Ueber die Kernteilung bei *Morus*. Bot. Mag. Tokyo **24**: 281–289. 1910.

tants are known to occur. But on the other hand, if the white mulberry were parthenogenetic through diploid eggs, the results obtained would still show that each sex does not tend to reproduce itself in this species.

In any event, the white mulberry is able to reproduce offspring of both sexual states from individuals which were originally male. Apparently the seven carpellate and three staminate plants were produced from the union of two cells derived from two individuals that were originally in the male state. Crew* has reported the production of two chickens, one a male and the other a female, from two parents which were both originally hens, but one of which reversed its sex because of a diseased condition.

ARISAEMA TRIPHYLLUM (L.) Torr.

The writer† published a paper in February 1922 on the control of sex in Jack-in-the-pulpit, and since the experiments were continued for two years after the first report, the results for these two years are herewith presented to complete the record. As reported in the previous paper, 25 pure carpellate plants, five intermediate plants and ten pure staminate plants were dug up and transplanted to the north side of the botanical greenhouse. They were treated for maleness and the next spring, 1920, the nine surviving staminate plants were still pure staminate, the five intermediate or monoecious plants were all pure staminate, and of the 25 originally pure carpellate plants, 21 were now pure staminate, two were intermediate, and two remained pure carpellate. They were immediately treated for reversal to femaleness and in the spring of 1921 came up as follows: The nine originally staminate plants were all pure carpellate except one individual which had three staminate flowers at the tip of its inflorescence. Of the five originally intermediate plants, four were pure carpellate and one which had branched gave rise to two staminate shoots. Of the 25 originally pure carpellate plants, one failed to bloom, one was pure staminate, one was intermediate carpellate

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* Crew, F. A. E. Complete sex-transformation in the domestic fowl. Jour. Hered. **14**: 361–362. 1923.

† Schaffner, John H. Control of the sexual state in *Arisaema triphyllum* and *Arisaema dracontium*. Am. Jour. Bot. **9**: 72–78.

with a single staminate flower at the tip of the inflorescence, and 22 were pure carpellate again.

In 1922, the plants having been treated for maleness, the control was as follows: Of the ten originally staminate plants six bloomed and all were pure staminate. Of the five originally intermediate plants, now increased to six, three bloomed, of which one was pure staminate, one was intermediate with only eight carpellate flowers at the base, and one was intermediate with a greater number of carpellate flowers than staminate ones. Of the 25 originally carpellate plants, one had twinned, both of which bloomed along with seven others. Of these nine plants, the twins and six others were pure staminate and one was intermediate with more carpellate flowers than staminate ones.

The plants were immediately treated again for femaleness and in the spring of 1923 the results were as follows: Of the ten originally staminate plants, one of which had died, eight bloomed; seven were pure carpellate and one was nearly pure carpellate, having a single imperfect staminate flower at the tip. Only three of the numerous shoots which were appearing in the patch bloomed and two of them were staminate and one intermediate but with mostly staminate flowers. These small plants, offshoots from the original corms, developed maleness in spite of the fact that the treatment given reversed all of the large mature corms. This was probably due to the small size of the offshoots and consequent lack of food supply, the leaf surface being, naturally, very small the previous year. Apparently most if not all small offshoots are at first staminate under ordinary conditions. Of the five originally intermediate plants, previously increased to six, four bloomed, all pure female. Of the 25 originally pure carpellate plants changed to 26, through one twinning by dichotomous branching, 13 bloomed, of which ten were pure carpellate, one was carpellate except that it had a single imperfect staminate flower at the tip of the inflorescence, one was intermediate, and one was pure staminate probably because of a reduction of its corm by branching. From the 25 originally pure carpellate plants, numerous offshoots had also appeared the two past years and of these seven came into bloom. There were five pure staminate plants, one staminate with a single carpellate flower at the base of the spadix, and one intermediate, but with more staminate flowers than carpellate ones. Thus, as in the

case of the offshoots from the originally staminate plants, the small offshoots from the originally carpellate plants were at first also staminate or nearly staminate in spite of the fact that the treatment given the previous year to induce femaleness produced the proper effect in the mature plants with large corms and large leaf surfaces.

It is evident that the control for the last two years was as perfect as for the first two years in all cases where the plant had not been decidedly reduced by vegetative propagation. In experimenting on sex control with *Arisaema triphyllum*, therefore, the process should not be continued beyond three or four years, unless special means are used to prevent any considerable amount of vegetative multiplication.

ARISAEMA DRACONTIUM (L.) Schott

Two records were also obtained in the summer of 1922 for the green-dragon. Two staminate plants which had been treated for femaleness changed to typical monoecious individuals. Monoecious plants had also been treated at the same time for maleness, but only two came out of the ground and neither bloomed. The treatment was too extreme. But the evidence shows again that *Arisaema dracontium*, as stated in my 1922 paper, changes from the staminate to the monoecious condition. With the cases previously reported, it is plain that *Arisaema dracontium* can be thrown from monoeciousness to pure staminateness and from pure staminateness to monoeciousness. It is probable that with a little experience this could be done as easily as the sexual condition can be changed in *Arisaema triphyllum*.

It is interesting to remember that *Arisaema* is at the top of one of the main lines of phyletic evolution in the Aroids. It is not only high in the scale of morphological advancement, but is the only genus that contains dioecious species The lowest Aroids have bisporangiate flowers, the great mass of higher Aroids are monoecious, and *Arisaema* has advanced just far enough into the dioecious stage to show still monoecious conditions, as in *Arisaema dracontium*. A correct taxonomy and phylogeny will do much to help us to a correct understanding of the fundamental properties and possibilities of a species.

Summary

1. *Thalictrum dioicum* was changed from a pure carpellate condition to an intermediate condition, showing maleness. Intermediate plants have also been changed to a pure carpellate condition and then back again to the original condition. These conditions, therefore, do not represent fixed, hereditary constitutions.

2. A pure carpellate *Cannabis sativa* plant has been rejuvenated and changed to a pure male expression and then back again to a pure female expression. Thus a cell lineage can change from one sexual state to the other and back again without any change in chromosome complement or hereditary constitution.

3. In *Morus alba*, offspring from seed produced on a reversed branch of a staminate plant did not tend to repeat maleness, but of ten individuals raised to maturity, seven were carpellate and three staminate.

4. Continuation of the experiments on *Arisaema triphyllum* show a nearly perfect control of the sex of the individual for the third and fourth years of the experiment. They also show that the small offshoots, whether they come from plants which are for the time being either carpellate or staminate and whether they have been treated for femaleness or maleness, are probably nearly always in the male condition at their first blooming period.

5. In 1922, two staminate plants of *Arisaema dracontium* were changed to typical monoecious individuals, adding to the record of definitely induced sex reversal in this species.

6. All of these experiments add decidedly to the weight of the accumulating evidence that sexuality is primarily a physiological condition, that it is primarily not at all Mendelian in nature and not amenable to Mendelian analysis; that it can frequently be controlled and reversed at will, even with our present crude methods, and that it is preeminently a subject for ecological and physiological experimentation.

7. A final conclusion is that the time has arrived for an honest revision of the ordinary textbooks and treatises dealing with heredity and sex, to conform them to the evidence established, and to discontinue the presentation of untenable hypotheses, which in the first place had little more evidence in fact as a basis for their promulgation than the fertile imagination of their proponents.

COLUMBUS, OHIO

Studies on the flora of northern South America—III

H. A. Gleason

(with plate 3)

New or noteworthy species of Centropogon and Siphocampylus

The genus *Centropogon*, so abundantly represented in the Andean region of northwestern South America, may be conveniently divided into three groups, based largely on superficial characters and not always indicative of true relationships among the species. One of these, characterized by the presence of branched hairs resembling those of *Verbascum*, has been discussed in the preceding number of this series. A second is characterized by the crowding of the flowers into a dense terminal cluster or raceme, while the third has axillary flowers subtended by normal foliage leaves. The second of these may in turn be divided into two portions, the one with large leaves, a crowded inflorescence, and erect sepals, commonly represented in herbaria by *C. speciosus* Planch., *C. Planchonis* Zahlbr., and the Central American *C. nutans* Planch. & Oerst., and aptly called section Amplifolii by Zahlbruckner; the other with small leaves, an elongate inflorescence, and reflexed sepals, best illustrated in American herbaria by the Bolivian *C. yungasensis* Britton. The third group is still more easily susceptible of division into a portion with penicillate anthers and another with appendiculate anthers, of which the widely distributed *C. cornutus* (L.) Druce (*C. surinamensis* L.) is the best known example.

Centropogon, Group Amplifolii

This easily recognized group of species, distinguished first by Zahlbruckner, is characterized chiefly by the inflorescence, which consists of an abbreviated, bracted raceme, in which the flowers are borne on short peduncles. The anther-appendage consists of concrescent hairs, producing a stiff, erect or reflexed, triangular scale; the leaves are large and thin and frequently broadest above the middle; the sepals are erect or appressed; the corollas are red; the pubescence, if any, is thin, and consists of straight or barely crooked short hairs. There is usually a sharp distinction in

size between the uppermost foliage leaf and the lowest bract, and the raceme is in some species conspicuously elevated above the uppermost leaf. In a few species, the raceme tends to elongate after flowering, or continues to bear crowded flowers at the end, while the lower, fruiting portion is elongated. In such cases, the members of the Amplifolii may bear a superficial resemblance to the related group Axillares, containing, among others, the well-known *C. cornutus* (L.) Druce. The group is also closely related to *C. yungasensis* Britton and its allies, which also have a terminal raceme, usually more elongate, however, and in which the sepals are distinctly spreading or reflexed. Thirty-five species of *Centropogon* have been described with these characters and probably belong to this group. Those known to me from South America, including several additional species, may be distinguished as follows:

A. Sepals contiguous or united at base, the sinuses therefore narrow and acute; anther-appendage without a basal zone of separate hairs.
  I. Calyx strongly gamosepalous.
    Calyx-lobes broadly ovate, prominently dentate.. 1. *C. roseus*
    Calyx-lobes triangular-lanceolate.
      Anther-tube densely hirsute..... 2. *C. gamosepalus*
      Anther-tube essentially glabrous..... 3. *C. capitatus*
  II. Sepals separate, or barely united at their bases.
    Sepals 4–5 mm. long, about equaling the hypanthium; leaves ample, obovate, abruptly apiculate ..... 4. *C. grandis*
    Sepals 6–12 mm. long, much exceeding the hypanthium.
      Calyx and corolla glabrous or essentially so.
        Sepals 5–6 mm. long, 3 mm. wide..... 5. *C. Bangi*
        Sepals 10 mm. long, 2 mm. wide..... 6. *C. amplifolius*
      Calyx and corolla distinctly hirtellous.
        Leaves closely puberulent on the veins beneath with very short brown hairs; sepals prominently veined..... 7. *C. congestus*
        Leaves hirsute beneath on the veins, and frequently also on the surface.
          Corolla about 30 mm. long.
            Leaves elliptic to obovate-oblong, broad.
              Sepals 16 mm. long; anthers pilose.... 8. *C. gesnerioides*
              Sepals 4–5 mm. long; anthers glabrous..... 9. *C. gesneraeformis*
            Leaves narrowly lance-oblong, about 6 times as long as wide..... 10. *C. angustus*

Corolla about 45 mm. long ..... 11. *C. serratus*

B. Sepals separated by broad, flat or rounded sinuses; anther-appendage (except in one species) with a distinct basal zone of hairs.

Sepals 1–4 mm. long, shorter than the hypanthium.

Leaves conspicuously long-acuminate at base.

Corolla stout, 12 mm. wide at the throat when pressed; sepals ovate, 2 mm. long .... 12. *C. curvatus*

Corolla slender, less than 10 mm. wide at the throat when pressed.

Calyx glabrous; sepals appressed ..... 13. *C. parvulus*

Calyx hirtellous; sepals recurved at the extreme tip ..... 14. *C. arcuatus*

Leaves rounded to broadly acute at base ..... 15. *C. cuspidatus*

Sepals 9–12 mm. long.

Leaves obtuse, softly pubescent beneath ..... 16. *C. beslerioides*

Leaves acute or acuminate, glabrous beneath.

Leaves minutely callous-denticulate; bracts obtuse, entire ..... 17. *C. pedicellaris*

Leaves finely ciliate, denticulate; bracts acute, denticulate ..... 18. *C. ciliatus*

Sepals 5–7 mm. long.

Corolla-tube abruptly bent, nearly or quite at right angles ..... 19. *C. aggregatus*

Corolla-tube straight or curved, but never approaching a right angle.

Leaves obovate-oblong, broadest well above the middle, long-cuneate at base ..... 20. *C. speciosus*

Leaves oblong, broadest at or below the middle.

Leaves softly pubescent beneath ..... 21. *C. albolimbatus*

Leaves glabrous beneath.

Leaves broadly rounded at base ..... 22. *C. prostratus*

Leaves acute at the base.

Anther-tube glabrous or essentially so .. 23. *C. sclanifolius*

Anther-tube hirsute on the dorsal side with violet hairs ..... 24. *C. Planchonis*

1. CENTROPOGON ROSEUS Rusby, Bull. N. Y. Bot. Gard. **8**: 123. 1912.

Bolivia: Tumupasa, Dept. La Paz, alt. 1800 ft., *Williams 584* (type, herb. N. Y. Botanical Garden) 10 Jan. 1902.

2. CENTROPOGON GAMOSEPALUS Zahlbr. Ann. Naturh. Hofmus. Wien **6**: 434. 1891.

Peru: Tarapoto, Dept. Loreto, *Spruce 4131* (type, herb. Kew).

3. CENTROPOGON CAPITATUS Drake, Jour. de Bot. **3**: 238. 1889.

Ecuador: Huacapamba, near Loja, *Poortman 198* (type, herb. Mus. Paris). Peru: Tarapoto, *Spruce 4132*.

4. CENTROPOGON GRANDIS (L.f.) Presl, Prod. Monog. Lobel. 48. 1836.

Lobelia grandis L.f. Suppl. 394. 1781.
Siphocampylus grandis G. Don, Gen. Syst. **3**: 702. 1834.

Colombia: near Bogota, alt. 2560 m., *Bonpland* (herb. Mus Paris); Tequendama, Dept. Cundinamarca, alt. 2400 m., *Pennell 1960*, 15 Sept. 1917; Salento, Dept. Caldas, alt. 2100–2500 m., *Pennell 8866*, 25–31 July 1922.

5. CENTROPOGON BANGI Zahlbr. Bull. Torrey Club **24**: 372. 1897.

Bolivia: Yungas, forest region northeast of La Paz, alt. 4000 ft., *Bang 500* (type); *Rusby 1093*, 1885.

6. CENTROPOGON AMPLIFOLIUS Vatke, Linnaea **38**: 716. 1874.

Bolivia: Santa Rosa, *Kuntze*. Peru: La Merced, Dept. Junin, alt. about 4000 ft., *Macbride 5662*, 27 Aug.–1 Sept. 1923.

7. **Centropogon congestus** n. sp. Stem herbaceous, strongly angled or grooved and somewhat flattened above, thinly puberulent when young, glabrous in age, the internodes 3–4 cm. long; leaf-blades thin and membranous, oblong to oblong-obovate, 15–28 cm. long, 6–10 cm. wide, abruptly short-acuminate, sharply serrulate (about 6 teeth per cm. of margin, 0.5 mm. high), each tooth with an oblong, intramarginal callosity, acuminate at the base into an indefinite petiole 1–3 cm. long, above glabrous on the surface, minutely puberulent on the midvein, beneath minutely puberulent, thinly on the surface, densely on the principal veins; lateral veins about 1 cm. apart, diverging at nearly right angles and arcuately ascending; inflorescence a terminal crowded raceme, at length elongate; floral leaves oblong to oblanceolate, 2–3 cm. long, sharply acute, cuneate at base, pubescent like the foliage leaves; pedicels 2–3 cm. long, slender, sparsely pubescent; hypanthium urceolate-hemispheric, 5 mm. high, 8 mm. wide when pressed, sparsely puberulent; sepals narrowly triangular, 10 mm. long, 3 mm. wide at base, about

7-ribbed, reticulate-veined, minutely puberulent, separated by acute sinuses, or gamosepalous for 1 mm. at the base; corolla red, sparsely puberulent, 30 mm. long, the tube prominently decurved, 23 mm. long, the lobes triangular-falcate, acuminate, prominently deflexed; filaments glabrous, exserted 5–7 mm.; anther-tube pubescent, especially at the base, the two lower anthers with a cartilaginous appendix. FIG. 1.

Type, *Pennell 10,169*, collected 30 Aug. 1922 at Pereira, Dept. Caldas, Colombia, altitude 1400–1500 m., and deposited in the herbarium of the New York Botanical Garden. Other collections are *Pennell, Killip & Hazen 8726*, Rio Quindio, above Armenia, Dept. Caldas, alt. 1400–1600 m., 25 July 1922; *Killip & Hazen 8764*, Salento, Dept. Caldas, alt. 1600–1900 m.. 27–31 July 1922; *Lehmann 1201;* and *Dawe 804*, Quindio, alt. 2000 m., 1918, in the same herbarium.

8. **Centropogon gesnerioides** n. sp. All parts of the plant subhirsute with straight or slightly curved, flattened, white hairs, tapering regularly from the base to the apex; stem herbaceous or suffruticose, strongly angled above, becoming glabrous with age; leaves obovate-oblong, thin and membranous, the largest 24 cm. long by 8.5 cm. wide, acuminate, minutely denticulate with callous, mainly intramarginal teeth (about 5–7 teeth per cm. of margin, 0.4 mm. high), acuminate at base into an indefinite petiole 2–3 cm. long, thinly pubescent above, more densely beneath, especially along the principal veins; lateral veins about 1 cm. apart, widely divergent and arcuately ascending; inflorescence a terminal raceme, at length elongate; floral leaves oblong, sessile, 2–3 cm. long, densely pubescent; pedicels slender, 2 cm. long; hypanthium urceolate-hemispheric, 4 mm. long, 7 mm. wide when pressed, densely pubescent; sepals triangular, erect or somewhat spreading, 16 mm. long, 5 mm. wide at base, acuminate, sparsely denticulate; corolla red, conspicuously hirsute, especially distally, 30 mm. long, the tube prominently decurved, 25 mm. long, the lobes triangular-falcate, acuminate, deflexed; filaments hirsute, especially toward the summit, exserted 3–4 mm.; anther-tube 7 mm. long, sparsely pilose, the two lower anthers with a cartilaginous appendix. FIG. 2.

Type, *Pitlier 691*, collected Dec. 1905, Cuestá de Tocotá, road from Buenaventura to Cali, Dept. El Valle, Colombia, altitude 1500–1900 m., and deposited in the United States National Herbarium. The species is sharply differentiated from *C. congestus* Gleason by its larger sepals and hirsute pubescence; from *C. gesneraeformis* Drake by its longer sepals, longer hairs, and hirsute anthers.

9. C. GESNERAEFORMIS Drake, Jour. de Bot. 3: 239. 1889.

Peru: Muña, Dept. Huánuco, alt. about 7000 ft., *Macbride 3982*, 23 May–4 June 1923. Ecuador: Huacapamba, near Loja, *Poortman 224* (type, herb. Mus. Paris). Colombia: "Balsillas" on Rio Balsillas, Dept. Huila, alt. 2100–2200 m., *Rusby & Pennell 790, 816*, 3–5 Aug. 1917; "La Gallera," Micay Valley, Dept. El Cauca, alt. 1400–1500 m., *Killip 7700*, 29–30 June 1922.

10. **Centropogon angustus** n. sp. Stem herbaceous, 6–12 dm. high, prominently grooved, closely and finely pubescent; leaves thin, membranous, narrowly oblong, 14–17 cm. long, 2.5–3 cm. wide, long-acuminate, prominently and irregularly serrulate (about 6 teeth per cm. of margin, 0.5–1 mm. high), each tooth with a narrow intramarginal callosity, long-cuneate at base into an indefinite petiole 1–2 cm. long, minutely and sparsely puberulent on the surface, densely pubescent on the veins above, sparsely short-hirsute on the veins beneath; lateral veins inconspicuous, 5–8 mm. apart, strongly ascending; inflorescence a crowded terminal raceme, the floral leaves resembling the cauline in form, and pubescence gradually reduced in size from 10 to 2 cm. in length; pedicels slender, finely pubescent, 3 cm. long at anthesis, ultimately elongating to 7 cm.; hypanthium urceolate-hemispheric, 4 mm. long, 7 mm. wide when pressed, thinly pubescent with short, straight, white hairs; sepals erect, narrowly triangular, 11 mm. long, 3.5 mm. wide at the base, acuminate, entire, pubescent like the hypanthium; corolla red, slightly decurved, about 30 mm. long, the tube 22 mm. long, minutely puberulent, the lobes narrowly triangular-falcate, acuminate, deflexed; filaments barely exserted, essentially glabrous; anther-tube 6–7 mm. long, glabrous, the two lower anthers with a cartilaginous appendix. FIG. 3.

Type, *Macbride 4967*, collected 17–26 July 1923, at Vilcabamba, hacienda on Rio Chinchao, Dept. Huánuco, Peru, altitude about 6000 feet, and deposited in the herbarium of The New York Botanical Garden (duplicate in herb. Field Museum). The species is distinguished from all of its relatives, including *C. congestus* Gleason, *C. gesneraeformis* Drake, and *C. gesnerioides* Gleason, by its narrow leaves and sepals, its large floral leaves, and elongate pedicels.

11. **Centropogon serratus** n. sp. Stem shrubby, climbing, densely pubescent or subtomentose above with stout, flattened, crooked, pale brown hairs, glabrescent with age, the internodes 2–4 cm. long; petioles stout, 5–8 mm. long, pubescent like the

stem; leaf-blades thin and membranous, broadly elliptic, 8–9 cm. long, 4.5 cm. wide, obtuse, broadly cuneate and somewhat inequilateral at base, prominently serrate (2–3 teeth per cm. of margin, 1–1.5 mm. high), each tooth with an oblong intramarginal callosity, very sparsely short-hirsute with pale brown hairs above, more prominently so on the surface beneath and densely on the principal veins; lateral veins 8–12 mm. apart, ascending at an angle of 45°, veinlets inconspicuously reticulate; inflorescence a crowded terminal raceme; floral leaves obovate, 20–25 mm. long, 12–17 mm. wide, short-petioled, pubescent like the cauline, but more densely; pedicels 2–3 cm. long, pubescent like the stem; hypanthium broadly hemispheric, 5 mm. high, 8 mm. wide when pressed, thinly hirsute with the same type of hairs; sepals erect, narrowly triangular, 6 mm. long, 3 mm. wide at base, densely hirsute, entire, separated by acute sinuses; corolla red, 45 mm. long, thinly pubescent with stout, flattened, white hairs, the tube straight, 40 mm. long, the lobes triangular-falcate, strongly deflexed; filaments barely exserted, glabrous; anther-tube 7 mm. long, purple, sparsely short-hirsute at the apex, the two lower anthers with a cartilaginous appendix. FIG. 4.

Type, *Killip 9759*, collected 14 Aug. 1922, Quebrada Cajamarca to "Mermillon," New Quindio Trail, Dept. Tolima, Colombia, and deposited in the herbarium of The New York Botanical Garden. The species is well characterized by its prominently serrate leaves, its coarse subtomentose pubescence, and its large corollas.

12. **Centropogon curvatus** n. sp. Stem apparently herbaceous, angled, sparsely pubescent above, soon becoming glabrous, the internodes 1–2 cm. long; leaf-blades narrowly elliptic-oblong, thin and membranous, 15–20 cm. long, 3–4, or rarely 5, cm. wide, acuminate, minutely denticulate with barely salient callous teeth (about 2 teeth per cm. of margin, 0.2 mm. high), acuminate at base into an indefinite petiole 12–20 mm. long, glabrous on both sides; lateral veins 15–20 mm. apart, ascending at an angle of 45°, the veinlets obscure and reticulate; inflorescence a terminal, few-flowered, subcapitate raceme, the floral leaves 15 mm. long; pedicels pubescent, 8–10 mm. long; hypanthium broadly hemispheric, 3 mm. high, 7 mm. wide when pressed, sparsely and minutely pubescent; sepals erect, appressed, triangular, 2.5 mm. long, 1.5 mm. wide at base, acute, minutely ciliate, separated by broad sinuses; corolla 38 mm. long, minutely puberulent, the tube prominently decurved and 12 mm. wide at the throat, the lobes broadly triangular-falcate, short, acuminate, deflexed; filaments glabrous, becoming pubescent at the summit, exserted 5–8 mm.; anther-tube 9 mm. long, densely

pubescent on the dorsal side with purple hairs, the two lower anthers with a cartilaginous appendix. FIG. 5.

Type, *Rusby & Pennell 948*, collected 1–8 Aug. 1917, east of Neiva, Dept. Huila, Colombia, altitude 1300–1800 m., and deposited in the herbarium of The New York Botanical Garden. The species is distinguished from others of this group with minute sepals by its unusually long and stout corolla.

13. **Centropogon parvulus** n. sp. Stem climbing, faintly striate or somewhat angled above, closely and scabrously pubescent, the internodes 2.5–5 cm. long; petioles stout, puberulent, 4 mm. long; leaf-blades oblong-lanceolate or narrowly oblong-elliptic, 8–12 cm. long, 25–35 mm. wide, acuminate, sharply serrulate (2–3 teeth per cm. of margin, 0.5 mm. high), gradually tapering to an acute base, glabrous above, minutely puberulent on the plane, prominently reticulate veins beneath; inflorescence a crowded terminal raceme, eventually elongate; floral leaves reduced to subulate bracts 4 mm. long; pedicels 15–25 mm. long, minutely bracteolate near the base; hypanthium subglobose, 7 mm. long, 6 mm. wide when pressed, glabrous; sepals appressed, triangular, 3 mm. long, 1 mm. wide at base, glabrous, separated by broad flat sinuses; corolla yellow, red toward the base, strongly decurved, scabrellate, the tube 30 mm. long, the lobes broadly triangular-falcate, strongly deflexed, the upper 10 mm. long; filaments included; anther-tube densely hirsute with pale yellow hairs, the two lower anthers with a cartilaginous appendix. FIG. 6.

Type, *Macbride 4848*, collected 19–23 June 1923, Cushi, Peru, altitude about 5000 feet, and deposited in the herbarium of The New York Botanical Garden (duplicate in herb. Field Museum). Its nearest relative is *C. arcuatus* Wimmer, in which the calyx and corolla are strongly hirtellous and the sepals recurved at the apex.

14. CENTROPOGON ARCUATUS Wimmer, Repert. Spec. Nov. **19**: 242. 1924.

Ecuador: Andes, *Spruce 5375* (duplicate of type in herb. Kew, Gray).

15. CENTROPOGON CUSPIDATUS A. DC. Prodr. **7**: 346. 1839.

Peru: La Merced, alt. about 4000 ft., *Macbride 5654*, 27 Aug.–1 Sept. 1923; Pampayacu, alt. 3500 ft., *Macbride 5088*, 19–25 July 1923; *Dombey* (type, herb. Mus. Paris).

16. CENTROPOGON BESLERIOIDES (H.B.K.) A. DC. Prodr. **7**: 346. 1839.

Lobelia beslerioides H.B.K., Nov. Gen. & Sp. **3**: 306. 1818.

Colombia: Popayan Andes (?), *Bonpland* (type, herb. Mus. Paris); "Pinares" above Salento, Dept. Caldas, alt. 2700–2900 m., *Pennell 9333*, 2–10 Aug. 1922; "Alaska" above Salento, alt. 3100–3400 m., *Pennell, 9376*, 7 Aug. 1922.

17. **Centropogon pedicellaris** n. sp. Stem herbaceous or suffruticose, irregularly striate when dry, glabrous below the inflorescence, the internodes 3–6 cm. long; petioles 15 mm. long, glabrous, flat, somewhat winged by the decurrent blade; leaf-blade elliptic-obovate, thin and membranous, bright green, the largest 17 cm. long by 7 cm. wide, the upper gradually reduced, abruptly narrowed into a rounded, sometimes mucronulate cusp 3 mm. long, minutely denticulate with broad, rounded, callous teeth (3–4 teeth per cm. of margin, barely salient), cuneate or acuminate at base, glabrous; veins plane but conspicuous, the laterals 10–15 mm. apart, ascending at an angle of 45°, the veinlets reticulate; inflorescence a subcapitate raceme, soon becoming elongate, the axis hirtellous; floral leaves obovate, persistent, obtuse, scabrellate-pubescent, 15–20 mm. long at anthesis, enlarging to 4–5 cm. long; pedicels slender, hirtellous, equaling the subtending leaves, after anthesis persistent, strongly angled, much thickened, and strongly curved; hypanthium hemispheric, 5 mm. high, 7–8 mm. wide when pressed, sparsely pubescent; sepals somewhat spreading, narrowly triangular, 9 mm. long, 2 mm. wide at base, puberulent, especially on the inner face, separated by narrow but flat sinuses; corolla red, sparsely puberulent, the tube nearly straight, 40 mm. long, the lobes triangular-falcate, 9–12 mm. long; filaments not exserted, glabrous; anther-tube 8 mm. long, glabrous, the two lower anthers with a cartilaginous appendix. FIGS. 7, 8.

Type, *Pennell 7619*, collected 1 July 1922, "San Jose," San Antonio, Dept. El Cauca, Colombia, altitude 2100–2500 m., and deposited in the herbarium of The New York Botanical Garden. Another collection from the same locality is *Pennell & Killip 7414*, 28 June 1922. *Lehmann 988* is also assigned to this species. In foliage and floral characters, *C. pedicellaris* stands close to *C. grandis* (L.f.) Presl, but is distinguished by its elongate raceme, its longer sepals with flat sinuses, and especially by its persistent thickened pedicels.

The same herbarium contains four sheets collected in the same immediate vicinity at "La Gallera," Micay Valley, two

of them on the same day as the type, in which the leaves are proportionately longer and much more acuminate, the floral leaves narrower and sharply acute, and the raceme less elongate. These may be tentatively considered as a variety of *C. pedicellaris*, under the name **gallerensis** n. var. They are *Killip 7701* (type), collected 29–30 June 1922 (duplicate in U. S. Nat. Herb.) *Killip 7695*, *7948*, and *7967*.

18. **Centropogon ciliatus** n. sp. Stem, foliage, inflorescence, hypanthium, calyx, and corolla glabrous; stem apparently herbaceous, greenish-brown, somewhat grooved or angled; leaf-blades obovate, deep green, membranous, 14 cm. long, 55–65 mm. wide, abruptly acuminate, cuneate at base into an indefinite petiole as much as 8 mm. long, sharply and finely denticulate-ciliate with triangular, callous-acuminate teeth, interspersed with slender, subulate, callous teeth of the same length (about 16 teeth per cm. of margin, 0.6–1 mm. long); veins barely elevated beneath, the laterals 10–15 mm. apart, broadly divergent and curved-ascending, the veinlets inconspicuously reticulate; inflorescence a subcapitate raceme; floral leaves ovate-oblong, 10–18 mm. long, acuminate, ciliate-denticulate; pedicels 3 cm. long; hypanthium urceolate-hemispheric, 5 mm. long, prominently 5-gibbous above the base; sepals erect, narrowly triangular, 10 mm. long, sparsely denticulate near the tip; corolla bright red, the tube slightly curved, 28 mm. long; filaments not exserted; anther-tube densely hirsute on the dorsal commissures with purple hairs, the two lower anthers with a cartilaginous appendix. FIG. 9.

Type, *Macbride 4028*, collected 23 May–4 June 1923, in dense forests at Muña, Peru, altitude about 7000 feet, and deposited in the herbarium of The New York Botanical Garden (duplicate in herb. Field Museum). The species is distinct within the group Amplifolii by its peculiar ciliate-denticulate leaves.

19. CENTROPOGON AGGREGATUS (Rusby) Gleason, Bull. Torrey Club **48**: 199. 1921.

Siphocampylus aggregatus Rusby, Bull. N. Y. Bot. Gard. **8**: 122. 1912.

Bolivia: Rio Machochorisa, near Atén, Dept. La Paz, alt. 3500 ft., *Williams 1579* (type, herb. N. Y. B. G.), 4 Aug. 1902.

20. CENTROPOGON SPECIOSUS Planch. Flore Serres **6**: 16. 1850–51.

Venezuela: Colonia Tovar, *Fendler 728;* Mérida, altitude 6000 ft., *Funck & Schlim 873* (type, herb. Mus. Paris). Colombia:

La Cumbre, Dept. El Valle, alt. 1550–2000 m., *Pennell 5150*, 7–10 May 1922, *Hazen 11,821*, 11–16 July 1922, *Killip & Hazen 11,115*, 9 Sept. 1922.

21. CENTROPOGON ALBOLIMBATUS Wimmer, Repert. Spec. Nov. **19**: 242. 1924.

Colombia: near Fusagasuga, Dept. Cundinamarca, *Linden 864* (duplicate of type in herb. Mus. Paris); *Jervise; Triana*.

22. CENTROPOGON PROSTRATUS Benth. Pl. Hartw. 212. 1845.

Ecuador: Quito Andes, *Hartweg 212* (type, herb. Kew).

23. CENTROPOGON SOLANIFOLIUS Benth. Pl. Hartw. 139. 1844.

Ecuador: Mountains of Paccha [Prov. El Oro] *Hartweg 779* (type, herb. Kew).

24. CENTROPOGON PLANCHONIS Zahlbr., Repert. Spec. Nov. **14**: 133. 1915.

Colombia: Rio Buga, near Cauca, alt. 1600 m., *Lehmann 776* (type); "Miraflores," Palmira, Dept. El Valle, alt. 1800–2100 m., *Killip 6144*, 27 May 1922; La Cumbre, El Valle, alt. 1600–1800 m., *Killip & Hazen 11114*, 9 Sept. 1922; Popayan, Dept. El Cauca, alt. 1600–1700 m., *Pennell & Killip 7192*, 24, 26 June, 1922; Apia, Dept. Caldas, alt. 1600–1900 m., *Pennell 10284*, 4–5 Sept. 1922; Rio San Rafael, below Cerro Tatama, Caldas, alt. 2200–2400 m., *Pennell 10321*, 7–11 Sept. 1922; "La Virginia," Libano, Dept. Tolima, alt. 1200–1500 m., *Pennell 3272*, 22 Dec. 1917.

CENTROPOGON, GROUP AXILLARES

Among the species with axillary flowers and appendiculate anthers, including *C. cornutus* (L.) Druce and *C. oblongus* Benth., the following two undescribed species have been distinguished.

Centropogon decemlobus n. sp. Stem shrubby, irregularly grooved and angled or somewhat flattened, glabrous, the internodes eventually 5 cm. ong; petioles slender, glabrous, 1 cm. long; leaf-blades membranous, pale green, narrowly ovate, 7–12 cm. long, 3–5 cm. wide, the upper gradually reduced, abruptly acuminate to an obtuse, mucronulate tip, minutely serrulate

with low, appressed or incurved teeth (about 3 teeth per cm. of margin, 0.3 mm. high), abruptly narrowed to a short-cuneate, somewhat inequilateral base, glabrous; lateral veins 7–9 mm. apart, broadly divergent, curved-ascending, the plane veinlets prominently reticulate beneath; peduncles axillary, 8–15 mm. long, closely pubescent, subulately bracteolate near the base; hypanthium hemispheric, 5 mm. high, 8 mm. wide when pressed, glabrous; sepals appressed, ovate-triangular, 2–3 mm. long, 2 mm. wide at the base, acute, entire, glabrous, separated by broad, distinctly convex or semicircular sinuses; corolla red, 45 mm. long, minutely puberulent, the tube 38 mm. long, slightly decurved, the lobes triangular-falcate; filaments exserted 2–5 mm., glabrous; anther-tube glabrous, 8–9 mm. long, the two lower anthers tipped with a cartilaginous appendix. FIG. 10.

Type, *Pennell 10,233*, collected 3 Sept. 1922, San Jose, Dept. Caldas, Colombia, altitude 1500–1800 m., and deposited in the herbarium of The New York Botanical Garden. Another collection is *Pennell 10,603*, Santuario, Dept. Caldas, alt. 2000–2300 m., 13–14 Sept. 1922, bearing depressed-globose fruits, and with most of the leaves sharply acuminate.

Centropogon Purdieanus n. sp. Stem herbaceous, probably climbing, strongly grooved and angled, thinly scabrellate-pubescent, the internodes 2–4 cm. long; petioles slender, 12–15 mm. long, pubescent; leaf-blades oblong-ovate, somewhat falcate, 8–11 cm. long, 3–4 cm. wide, acute, crenulate, with triangular callous teeth between the crenations (about 3–4 teeth per cm. of margin), broadly cuneate to obtuse and somewhat inequilateral at base, sparsely puberulent on both surfaces, especially on the veins beneath; lateral veins 12–18 mm. apart, strongly curved-ascending, anastomosing near the margin, the veinlets plane and reticulate; peduncles axillary, 12–15 mm. long, densely pubescent; hypanthium broadly hemispheric, 5 mm. high, 9 mm. wide when pressed, thinly but closely pubescent; sepals erect or somewhat spreading, broadly triangular, 1.5–2 mm. long and wide, thinly pubescent; corolla 5 cm. long, somewhat decurved, sparsely puberulent, red, the lobes triangular-falcate; filaments glabrous; anther-tube 9 mm. long, glabrous except for a few white hairs near the tip, the two lower tipped with a cartilaginous appendix. FIG. 11.

Type, *Purdie*, collected in the mountains of New Granada, and deposited in the Gray Herbarium. The herbarium at Kew contains six sheets of this species, all collected by Purdie, and probably all duplicates. One bears the number "seeds 640" and some are labeled "woods of Antioquia." The species differs

from *C. decemlobus* Gleason in the conspicuous pubescence which extends to almost every part of the plant.

Recent collections in Ecuador and Colombia also include four undescribed species with axillary peduncles and penicillate anthers.

Centropogon leucophyllus n. sp. Stem herbaceous, finely striate, minutely puberulent when young, becoming glabrous on the first expanded internode; petioles 8–20 mm. long, about one third as long as the blade, margined, ciliate; leaf-blades ovate, 35–60 mm. long, 14–28 mm. wide, acute or subacuminate to a blunt tip, crenate (about 4 or 5 teeth per cm. of margin, 0.5 mm. high or less), broadly obtuse to rounded and somewhat inequilateral at base, dull green and glabrous above, pale green and very minutely puberulent beneath; lateral veins 4–6 pairs, mostly approximate toward the base of the blade, strongly ascending, veinlets inconspicuous, scarcely anastomosing; peduncles axillary, 3–5 cm. long, slender, minutely puberulent, subulate-bibracteolate near the base; hypanthium hemispheric, 4 mm. high, 6 mm. wide when pressed, minutely puberulent; sepals widely spreading to subreflexed, oblong-triangular, 8 mm. long, 2.5 mm. wide at base, tapering regularly to the apex, minutely ciliate and puberulent, with 2 or 3 teeth on each side, separated by narrow acute sinuses; corolla purple, tipped with white, minutely puberulent, the tube lightly decurved, about 25 mm. long, the lobes almost straight, the upper oblong, 8 mm. long, the lateral and lower triangular, 5–6 mm. long; filaments not exserted, glabrous; anther-tube 5 mm. long, glabrous, the two lower anthers penicillate; fruit a berry. FIG. 12.

Type, *Pennell 10,490*, collected 8–10 Sept. 1922, Cerro Tatama, Dept. Caldas, Colombia, altitude 3200–3400 m., and deposited in the herbarium of The New York Botanical Garden. Other collections are *Pennell 10,419*, Rio San Rafael, below Cerro Tatama, altitude 2500–2800 m., 7–11 Sept. 1922; *Pennell 9351*, "Pinares" above Salento, Dept. Caldas, alt. 2700–2900 m., 2–10 Aug. 1922; and *Dawe 736*, Ruiz, at Termales, alt. 3000 m., 1918. These specimens are constant in the character of the flower, venation, and pubescence, but differ considerably in the size and shape of their leaves. In Dawe's collection these are broadly ovate, blunt at the apex, truncate or subcordate at base, and not exceeding 25 by 30 mm. in size; in *9351* they are oblong-ovate, as large as 26 by 58 mm.; and in *10,419*, which was noted by the collector as growing in the shade, they are very thin, elongate-ovate, and as large as 46 by 96 mm.

Centropogon carpinoides n. sp. Stem herbaceous, glabrous, pale greenish brown or purplish, strongly and irregularly grooved and angled, the internodes mostly 2–4 cm. long; petioles slender, 2–3 cm. long, narrowly margined, minutely puberulent; leaf-blades membranous, triangular-ovate, 5–6 cm. long, 35–45 mm. wide, or the upper notably reduced, broadest near the base, gradually tapering or subacuminate to a blunt apex, broadly cuneate to truncate or subcordate at the inequilateral base, prominently crenate (3–7 teeth per cm. of margin, 0.4–1 mm. high), dull green and glabrous above, minutely pubescent on the veins beneath; lateral veins 4–7 pairs, about half of them approximate in the basal fourth of the blade, strongly ascending, the veinlets inconspicuously reticulate; peduncles numerous, axillary, about 25 mm. long, glabrous, the prominent subulate bracteoles 5 mm. long; hypanthium hemispheric, 5 mm. high, 6 mm. wide when pressed, glabrous; sepals erect or somewhat spreading, foliaceous, triangular-lanceolate, 12 mm. long, 2 mm. wide at base, acuminate, glabrous, reticulately veined, with 1–3 salient callous teeth on each side, separated by narrow acute sinuses; corolla apparently red, tipped with white, thinly puberulent, the tube 3 cm. long, nearly straight, the upper lobes oblong, 9 mm. long, nearly straight, the lateral and lower triangular-falcate, decurved, 6 mm. long; filaments not exserted, glabrous; anther-tube glabrous, 5 mm. long, the two lower anthers penicillate; fruit a globose dry berry, 18 mm. in diameter. FIG. 13.

Type, *Pennell 10,348*, collected 7–11 Sept. 1922, Rio San Rafael, below Cerro Tatama, Dept. Caldas, Colombia, altitude 2400–2600 m., and deposited in the herbarium of The New York Botanical Garden. Closely related to *C. leucophyllus* Gleason, from which it differs in its glabrous stem and leaf-surface, its glabrous hypanthium, its longer, reticulately-veined and glabrous sepals, its narrower petioles, and strongly grooved stem.

Both species are related to *C. erythranthus* Zahlbr., in which the leaves are coarsely and irregularly toothed and distinctly narrowed to the base, and the anthers are villous. It may be noted that the length of the sepals in the type specimen of *C. erythranthus* is only 6–7 mm., instead of 11–13 mm. as stated by Zahlbruckner.

Centropogon griseus n. sp. Stems stout, woody, striate, gray with short but close pubescence, the internodes 1–3 cm. long; petioles slender, 12–15 mm. long, densely gray-pubescent or subtomentose; leaf-blades firm, broadly ovate, 4–6 cm. long, 25–35 mm. wide, abruptly acuminate, minutely serrulate with appressed teeth (about 6 teeth per cm. of margin, 0.2 mm. high),

broadly truncate to subcordate below and abruptly cuneate to the petiole, minutely puberulent above, thinly pubescent beneath, especially along the principal veins; lateral veins 4 or 5 pairs, ascending at an angle of about 45°, anastomosing near the margin, the veinlets inconspicuous; peduncles axillary, 3–5 cm. long, densely pubescent or subtomentose, callous-bracteolate at the base; hypanthium semi-ovoid, 4 mm. long, densely pubescent; sepals thick, erect, narrowly triangular, 3.5 mm. long, obtuse, densely pubescent; corolla 3 cm. long, thinly puberulent, the tube almost straight, strongly contracted above the base, gradually expanded to the throat, the lobes narrowly triangular-falcate, strongly decurved; filaments exserted about 5 mm., conspicuously villous; anther-tube 7 mm. long, prominently white-villous in the furrows, the two lower anthers penicillate. FIG. 14.

Type, *Rose & Rose 23,383*, collected 6–15 Oct. 1918, Portoviejo, Ecuador, and deposited in the United States National Herbarium. Undoubtedly related to the two preceding species, but sharply distinguished from them by its dense and close pubescence and short sepals.

Centropogon Hitchcockii n. sp. Stem simple, erect, 12–18 dm. high, grooved, sparsely tomentulose when young, glabrescent with age, the internodes 5–10 mm. long; petioles slender, sparsely pubescent, 10–12 mm. long; leaf-blades thin, oblong-linear, somewhat falcate, 10–12 cm. long, 13–16 mm. wide, long-acuminate, conspicuously denticulate, with black, callous, salient, subulate teeth (about 7 teeth per cm. of margin, 0.4–0.5 mm. high), long-cuneate to the base, thinly pubescent above with short, flat, crooked, pale brown hairs, pubescent on the veins beneath with the same type of hairs, densely so or tomentulose on the midvein; lateral veins about 1 cm. apart, ascending at an angle of about 30°, the veinlets closely but inconspicuously reticulate; peduncles axillary, 8–9 cm. long, tomentulose above to thinly pubescent at the base with crooked hairs, ebracteolate; hypanthium urceolate-hemispheric, 5 mm. high, 8 mm. wide when pressed, prominently ribbed or angled, densely pubescent; sepals recurved, linear, 14 mm. long, thinly pubescent on the outer face and margin, frequently involute, entire, separated by rounded, narrow sinuses; corolla red, softly pubescent with white, red-tipped hairs, the tube slightly curved, 3 cm. long, the lobes triangular-falcate, decurved, the upper 10 mm., the lower 6 mm. long; filaments exserted 10 mm., minutely villous; anther-tube 8 mm. long, densely hirsute, especially distally, with purple hairs, the two lower bearded at the apex. FIG. 15.

Type, *Hitchcock 21,681*, collected 12–13 Sept. 1923, between Cuenca and Huigra, Ecuador, altitude 2700–3000 m., and depos-

ited in the herbarium of The New York Botanical Garden (duplicate in U. S. National Herbarium). The species finds its nearest relative in *C. Sodiroanus* Zahlbr., in which the leaves, although narrow, are proportionately broader, the sepals only 8 mm. long and strictly erect, the foliage and flowers glabrous, and the anther-tube covered with white hairs.

SIPHOCAMPYLUS NIVEUS AND TWO RELATED SPECIES

A small group of Andean species of *Siphocampylus* is strikingly characterized by a broadly campanulate, almost regular corolla, with unusually short triangular lobes, and by heavy, rugose leaves densely covered on the lower surface by white or gray tomentum. Three species are represented in the collections of the National Herbarium, the Gray Herbarium, and The New York Botanical Garden, distinguished as follows:

Sepals narrowly oblong, 2–3 mm. wide, 8–10 mm. long..... *S. Jamesonianus*
Sepals narrowly linear, 1 mm. or less wide, 8–12 mm. long.
  Leaves elliptic, broadest at or below the middle, obtuse at the base; corolla somewhat decurved, 12–15 mm. wide at the throat when pressed..... *S. niveus*
  Leaves narrowly oblong-obovate, broadest above the middle, long-cuneate at the base; corolla straight, 20 mm. wide at the throat when pressed..... *S. Pennellii*

SIPHOCAMPYLUS JAMESONIANUS (Presl) A. DC. in DC. Prodr. **7**: 402. 1839; Jameson, Syn. Pl. Aequat. **2**: 179. 1865.

Lobelia Jamesoniana Presl, Prodr. Monog. Lobel. 36. 1836.
Lobelia pulverulenta Hook. Jour. Bot. Hook. **1**: 231. *pl. 131.* 1834; not *L. pulverulenta* Pers.
Byrsanthes Halliana Presl, *l. c.* 42. 1836.
Siphocampylus Hallianus Vatke, Linnaea **38**: 732. 1874.

Ecuador: Ambato, Prov. Tungurahua, *Pachano 182*, March 1919; *Spruce 4976*. Jameson's type locality was vicinity of Baños, Prov. Tungurahua, alt. 6000 feet.

SIPHOCAMPYLUS NIVEUS (Willd.) Vatke, Linnaea **38**: 732. 1874.

Lobelia nivea Willd.; Roem. & Schult. Syst. **5**: 58. 1819.
Siphocampylus lanatus Benth. Pl. Hartw. 214. 1845.

Colombia: Bogota, *Bonpland* (type); *Triana 1556; Hartweg 1188* (type of *S. lanatus*), Purace, Prov. Popayan [Dept. El Cauca]; *Lehmann 5637; Pennell & Killip 6451*, "San Isidro," Purace, Dept. El Cauca, alt. 2200–2500 m., 10–11 June 1922.

Siphocampylus Pennellii n. sp. Stem herbaceous, stout, erect, densely white-lanate above, becoming glabrous with age; leaves crowded, the internodes about 1 cm. long, ascending, coriaceous, narrowly oblong-obovate, the largest 15 cm. long by 3.5 cm. wide, the upper gradually reduced to 7 cm. long by 2 cm. wide, rounded at the apex, broadest well above the middle, entire, cuneate at the base, on stout, tomentose petioles 10–15 mm. long, above dull green, glabrous, shining, and strongly rugose with deeply impressed veins, beneath densely white-tomentose; peduncles stout, ascending, 6–12 cm. long, exceeding the subtending leaves, ebracteolate, densely tomentose; hypanthium broadly obconic, 10 mm. high, 5-ribbed, densely tomentose; sepals linear, ascending, 8 mm. long, somewhat involute, densely tomentose on the outside, thinly lanate within; corolla broadly campanulate, densely white-tomentose without, yellowish-white, glabrous, and strongly rugose within; tube about 20 mm. long, 22 mm. wide at the throat when pressed, the lobes erect, broadly triangular-ovate, subequal, acute or subacuminate, the largest 12 mm. long by 10 mm. wide, the smallest 8 mm. long by 9 mm. wide; filaments glabrous, shorter than the corolla-lobes; anther-tube gently decurved, 9 mm. long, glabrous or with a few long white hairs in the commissures, all anthers densely bearded at the summit with yellowish hairs; fruit a capsule. FIG. 16.

Type, *Pennell 7509*, collected 29–30 June 1922, on Mount Trompo del Puerco, Dept. El Cauca, Colombia, altitude 2500–2900 m., and deposited in the herbarium of The New York Botanical Garden.

SIPHOCAMPYLUS UMBELLATUS AND THREE NEW RELATED SPECIES

SIPHOCAMPYLUS UMBELLATUS (H.B.K.) G. Don, Gen. Syst. 3: 702. 1834.

? Lobelia gigantea Cav. Ic. 6: 9. *pl. 513.* 1801.
Lobelia umbellata H.B.K. Nov. Gen. & Sp. 3: 304. *pl. 268.* 1818.
Lobelia ayavacensis Willd.; Spreng. Syst. 1: 709. 1825.
Siphocampylus ayavacensis Steud., Nomencl. ed. 2. 2: 63. 1840.

Until the type specimen of Cavanilles shall have been examined, and its identity with *L. umbellata* H.B.K. established or re-

futed, G. Don's name for this widely variable species had best be maintained. If the two are identical, and it is quite probable they are, the name will become *S. giganteus* (Cav.) G. Don (type locality, between Guaranda and the mountain of San Antonio, Prov. Bolivar, Bolivia). Willdenow's name was a mere manuscript note written by him on a specimen of this species collected by Bonpland at Ayavaca, Dept. Piura, Peru, and doubtless a duplicate of the type of *L. umbellata* H.B.K., apparently in a desire to conserve the name *L. umbellata* Vest, published in 1819.

Few species of the genus are so well represented in herbaria, and but few others show such a wide variation, extending to the proportion and tomentum of the leaves, the amount of pubescence on the anthers, and the length, pubescence, and serration of the sepals. I have not been able to recognize lines of specific demarcation among them. The sheets examined by me are *André 2928*, *Anthony & Tate*, *Bonpland* (3), *Couthoy*, *Hall* 57, *Jameson 238,613*, *Spruce*, *Spruce 5164*, *Triana 1571*, and the following recent collections—Colombia: "Canaan," Mt. Purace, *Pennell & Killip 6500*, 11–13 June 1922; "La Gallera," Micay Valley, Dept. El Cauca, *Killip 7979*, 1 July 1922. Ecuador: "La Rinconada," between Ibarra and Tulcán, Prov. Carchi, *Hitchcock 20,952*, 10–11 Aug. 1923; vicinity of Nabón, Prov. Azuay, *Rose*, *Pachano & Rose 23,019*, 25 Sept. 1918; vicinity of Cuenca, Prov. Azuay, *Rose*, *Pachano & Rose 23,806*, 17–24 Sept. 1918; between Cuenca and Huigra, Prov. Canar, *Hitchock 21,668*, 12–13 Sept. 1923; vicinity of Canar, *Rose & Rose 22,714*, 15 Sept. 1918; Mt. Pichincha, *Mille 359;* Tambillo, Prov. Pichincha, *Mille 375*, Aug. 1923. Altitudes are 2200–3400 m.

The following three species are of the same general affinity, having large coarse flowers, varying from greenish-yellow to nearly white in color, but differing conspicuously in the characters of the hypanthium or calyx.

Siphocampylus cylindricus n. sp. Stems suffruticose, 10–15 dm. high, thinly tomentulose above, becoming merely puberulent in age, the internodes 5–15 mm. long; petioles stout, tomentose, 10 mm. long; leaf-blades firm, ovate-elliptic, 20–25 cm. long, 7–9 cm. wide, obtuse, broadly cuneate to an obtuse or subacute base, finely denticulate with blunt, broadly triangular teeth (about 4 teeth per cm. of margin, 0.4–0.6 mm. high), above dark green, rugulose, thinly pubescent with short crooked hairs

on the surface and tomentose along the midvein, beneath closely and roughly brown-tomentulose; lateral veins 6–10 mm. apart, ascending at an angle of 60°, frequently branched or anastomosing, the veinlets prominently reticulate above, obscure beneath; peduncles stout, axillary, erect, 14–17 cm. long, brown-tomentulose; hypanthium cylindric above a turbinate base, 20–25 mm. long, 15–17 mm. wide when pressed, thinly tomentulose; sepals erect, stout, linear-lanceolate, 30–35 mm. long, 3 mm. wide at base, tapering regularly to the acuminate subulate tip, prominently spinulose-denticulate with 4–6 black callous teeth 1 mm. long on each side, thinly tomentulose on both sides; corolla greenish-yellow, coarsely tomentose, the tube stout, 17 mm. long, 12 mm. wide at the throat when pressed, the lobes linear-falcate, all strongly decurved, the upper about 32, the lower about 16 mm. long; filaments thinly villous; anther-tube about equaling the upper corolla-lobes, 12 mm. long, densely pubescent in the fissures with stout, somewhat curved, short, brown hairs, the two lower anthers densely bearded with pale, slender, flexuous hairs. FIG. 17.

Type, *Pennell 3142*, collected 17 Dec. 1917 at "Rosalito," Dept. Tolima, Colombia, altitude 2700–3000 m., and deposited in the herbarium of The New York Botanical Garden. A second sheet is *Dawe 740*, Ruiz, Colombia, alt. 3000 m., 1918; *Triana 1582* is certainly closely related and may be the same species.

Siphocampylus stellatus n. sp. Stem stout, angled, floccose-tomentulose with brown hairs, the internodes 10–15 mm. long; petioles stout, 5–8 mm. long, tomentose like the stem; leaf-blades firm, narrowly oblong, 9–11 cm. long, 28–32 mm. wide, broadest at or slightly below the middle, obtuse, finely denticulate with black, callous, salient teeth (6–7 teeth per cm. of margin, 0.3–0.4 mm. high), abruptly acute or short-cuneate at base, dark green, rugose, and almost glabrous above, except for short, flat, brown, crooked hairs along the midvein, beneath densely pubescent with the same type of hairs on all veins and veinlets, simulating a tomentose surface; lateral veins widely ascending, lightly arcuate, the veinlets prominently reticulate above, obscure beneath; peduncles axillary, ascending, 10 cm. long, below thinly, above densely stellate-tomentose; hypanthium cylindric above a turbinate base, 15–17 mm. long, 11 mm. wide when pressed, densely stellate-tomentose with brown hairs; sepals linear-triangular, 15–17 mm. long, 3 mm. wide at the base, tapering regularly to the tip, with numerous teeth like those of the leaves, stellate-tomentose; corolla thinly but conspicuously stellate-tomentose, the tube 18 mm. long, the lobes linear-falcate, strongly decurved, the upper 32 mm., the lower 21 mm. long; filaments glabrous; anther-tube 10 mm. long,

densely hirsute on the connectives with orange-yellow, stiff, ascending hairs, the two lower bearded with more slender, longer, somewhat curved hairs. FIG. 18.

Type collected by I. F. Holton, 27 Jan. 1853, between Volcancito and Roble [Old Quindio Trail], Colombia, and deposited in the herbarium of Columbia University at The New York Botanical Garden. Another sheet was collected by Purdie, May 1846, on the flat summit of the Quindio, Colombia. It agrees with the type in every essential feature, but averages a little larger in all dimensions.

S. stellatus is obviously closely related to *S. cylindricus* Gleason, but is distinguished at once by the stellate pubescence and short sepals.

Siphocampylus Hazenii n. sp. Stem stout, hollow above, irregularly angled, somewhat scurfy, the internodes much abbreviated at the summit; petioles stout, 3–4 cm. long, scurfy like the stem; leaf-blades oblong-elliptic, firm, 20–30 cm. long, 7–9 cm. wide, acute, long-cuneate to the base and somewhat decurrent on the petiole, finely denticulate with low, dark, obtuse, subcallous teeth (3–4 teeth per cm. of margin. 0.4–0.7 mm. high), rugulose and thinly arachnoid-tomentulose above when young, becoming glabrate with age, beneath pale green, densely arachnoid-tomentulose when young, thinly arachnoid at maturity, especially along the veins, and persistently scurfy on the midvein; veins lightly impressed above, prominently elevated beneath, the laterals 6–10 mm. apart, somewhat arcuate, strongly ascending, the veinlets conspicuously reticulate; peduncles stout, axillary, erect or ascending, 12–14 cm. long, thinly arachnoid, glabrescent with age; hypanthium short-cylindric or broadly urceolate, 17 mm. high and wide, thinly scurfy; calyx glabrous, purplish, gamosepalous, 2-lipped, the upper lip 12–15 mm. long, barely united with the lower, which is 25 mm. long; calyx-lobes broadly triangular, erect, acute, 8 mm. long, 6 mm. wide; corolla yellowish, thinly scurfy, its tube shorter than the calyx, about 20 mm. long, lobes linear-falcate, strongly decurved, the upper 30 mm. long, 5 mm. wide; filaments barely exserted, glabrous; anther-tube 13 mm. long, glabrous, strongly decurved at the summit, the two lower anthers densely bearded with crooked hairs. FIG. 19.

Type, *Killip & Hazen 12,081*, collected 27–30 July 1922, Rio Quindio, near Salento, Dept. Caldas, Colombia, altitude 1500–1600 m., and deposited in the herbarium of The New York Botanical Garden. Other specimens, all from Quindio, so far as noted, are *Purdie*, *Goudot*, *André 2097*, and *Linden 1073* (herb. Kew), and *Triana 1573* (herb. Mus. Paris).

There are few species of *Centropogon* or *Siphocampylus* with strongly gamosepalous calyx, and this is the only one, so far as known to me, with a corolla like that of the group with the well-known *S. umbellatus* G. Don.

NEW SPECIES RELATED TO S. VOLUBILIS AND S. BENTHAMIANUS

The numerous species of this general affinity are readily recognized in herbarium material, although they are not easy to characterize. They all have large showy axillary flowers, mostly on long peduncles, corollas much constricted just above the base and greatly expanded toward the summit, penicillate anthers, and long-petioled leaves, mostly ovate or cordate in outline. Within their number two well-marked groups may be distinguished. The first of these has a turbinate receptacle, widest at the summit, while in the second the receptacle is more or less pyriform, widest below the summit and conspicuously narrowed to the base of the sepals. Both groups are abundantly represented in herbaria and have frequently been in cultivation, which has led to the publication of several names based solely on greenhouse material Of the five following species, the first two have the turbinate or obconic receptacle of *S. volubilis* (H.B.K.) G. Don, and the last three have the pyriform receptacle of *S. Benthamianus* Walp. (*S. cordifolius* Benth.).

Siphocampylus dentatus n. sp. Stem herbaceous, probably climbing, pale greenish-brown, essentially glabrous; internodes 2–4 cm. long; petioles slender, tortuous near the base, 1 cm. long, lengthening to 2 cm. at maturity, thinly puberulent; leaf-blades membranous, ovate, 8 cm. long, 4.5 cm. wide, the upper gradually reduced, long-acuminate, cordate at base, sharply, coarsely, and irregularly dentate with triangular and erect, or falcate and retrorse teeth (about 4 teeth per cm. of margin, 1–2 mm. long), minutely pubescent above when young, soon glabrescent except on the midvein, glabrous on the surface and closely puberulent on the veins beneath; lateral veins 4–5 pairs, the basal widely divergent, the upper strongly ascending, the veinlets obscure, plane, reticulate; peduncles axillary, slender, 4.5 cm. long, sparsely puberulent, subulately bibracteolate at the base; hypanthium broadly obconic, 6 mm. high, 9 mm. wide when pressed, thinly puberulent, prominently 10-nerved; sepals erect or somewhat spreading, foliaceous, narrowly triangular, 14–17 mm. long, 2.5 mm. wide at base, tapering regularly to the apex, prominently hirtellous on the midvein,

conspicuously ciliate, finely reticulate, separated by narrow acute sinuses; corolla rose-pink, thinly puberulent on the ribs, the tube slender, 40 mm. long, 7 mm. wide at the throat when pressed, the lobes linear, 13–18 mm. long; filaments not exceeding the upper corolla-lobes, glabrous; anther-tube 7 mm. long, glabrous, the two lower anthers penicillate. FIG. 20.

Type, *Hazen 9663*, collected 7 Aug. 1922, Rio Coello to San Miguel, New Quindio Trail, Dept. Tolima, Colombia, and deposited in the herbarium of The New York Botanical Garden. Other collections, also from Tolima, are *Killip & Hazen 9621*, between "El Eden" and "La Palmilla," Old Quindio Trail, alt. 1800–2300 m., 8 Aug. 1922, and *Killip 9738*, Rio Paloma, New Quindio Trail, 13 Aug. 1922. *Triana 1539* seems to be also the same species. Most closely related to *S. odontosepalus* Vatke, from which it differs in its triangular, ciliate, entire sepals and its coarsely dentate leaves.

Siphocampylus pilosus n. sp. Stem herbaceous, nearly terete, densely pubescent or subtomentose with pale brown hairs, the internodes 1–3 cm. long; petioles stout, frequently deflexed, 6–10 mm. long, densely pubescent; leaf-blades thin, dull green, ovate, 6–7 cm. long, 3–3.5 cm. wide, broadest below the middle, gradually tapering or subacuminate to a straight or falcate blunt tip, finely and irregularly serrate (about 6 teeth per cm. of margin, 0.2–0.5 mm. high), cordate at base (sinus 2–4 mm. deep), or broadly truncate, sparsely and minutely pubescent above, glabrous in age except along the midvein, densely short-hirsute beneath (hairs straight, 0.3 mm. long), especially along the veins, where the hairs are twice as long; lateral veins 8–10 pairs, nearly straight, ascending at an angle of about 45°, the plane veinlets finely but conspicuously reticulate; floral leaves resembling the cauline, but 25–30 mm. long; peduncles axillary, spreading or deflexed, frequently tortuous, densely pubescent, 10–15 mm. long; hypanthium broadly obconic, 4 mm. long, 8 mm. wide when pressed, densely pubescent, 10-ribbed; sepals spreading or reflexed, linear-oblong, 4 mm. long, blunt, entire, densely pubescent, separated by broad flat sinuses; corolla scarlet, 5 cm. long, thinly pubescent with purple hairs, the tube lightly decurved, much contracted above the base, 7 mm. wide at the throat when pressed, the lobes linear-oblong, acute, the upper 15 mm. long; filaments glabrous, about equaling the upper corolla-lobes; anther-tube 6 mm. long, densely hirsute in the fissures, the two lower anthers penicillate. FIG. 21.

Type, *Rusby & Pennell 680*, collected 1–8 Aug. 1917, east of Neiva, Dept. Huila, Colombia, altitude 2200–2500 m., and de-

posited in the herbarium of The New York Botanical Garden (also Gray Herbarium). Other collections, also from Huila, are *Rusby & Pennell 908*, "Balsillas" on Rio Balsillas, alt. 2000–2300 m., 3–6 Aug. 1917, and *Bro. Ariste-Joseph B–77*, El Gigante, 1920 (U. S. Nat. Herb.). The species differs from *S. hispidus* Benth. in its shorter, entire sepals, its shorter peduncles, and its finely serrulate leaves with shallower basal sinus.

Siphocampylus venosus n. sp. A climbing shrub; stems reddish-brown, glabrous, strongly angled or subulate, freely branched above; petioles tortuous, glabrous, 5–8 mm. long,; leaf-blades broadly ovate-oblong, firm, 25–40 mm. long, 15–25 mm. wide, abruptly short-acuminate, broadly rounded to truncate or subcordate at base, sharply and irregularly serrate (3–5 teeth per cm. of margin, 1–3 mm. long), glabrous and rugulose with impressed veins above, pale green and glabrous beneath; lateral veins 4–6 pairs, ascending at an angle of about 45°, the purple-black veinlets prominently reticulate; peduncles axillary, stout, somewhat flexuous, glabrous, ebracteolate, 5–8 cm. long; hypanthium obovoid-pyriform, broadest above the middle, 9 mm. long, 7–8 mm. wide when pressed, faintly ribbed, glabrous; sepals erect or slightly recurved at the apex, oblong-triangular, 2–3 mm. long, acuminate, glabrous, separated by rounded sinuses as wide as the sepal; corolla red, 5 cm. long, glabrous, the tube gradually contracted from the base to a width of 1.5 mm., thence expanding to a width of 9 mm. at the throat when pressed, the lobes narrowly triangular, acuminate, 9 mm. long; filaments barely exserted, glabrous; anther-tube dull gray, 8–9 mm. long, glabrous or sparsely pilose with long white hairs, the two lower anthers penicillate. FIG. 22.

Type, *Killip & Hazen 9427*, collected 1–2 Aug. 1922, "Magaña," Old Quindio Trail, Dept. Caldas, Colombia, altitude 3200–3300 m., and deposited in the herbarium of The New York Botanical Garden. A member of the same group with *S. megalanthus* Zahlbr., *S. pubescens* Benth., and *S. Benthamianus* Walp., and differing from all of these by its glabrous foliage and flowers; from related glabrous species it is distinguished by its broad leaves and short sepals. A second collection, apparently representing a shade form, is *Pennell 9359*, also from Caldas, "Pinares" above Salento, alt. 2700–2900 m., 2–10 Aug. 1922.

Siphocampylus obovoideus n. sp. Climbing shrub, glabrous except the stamens; stems slender, pale brown, finely striate, the internodes 2–4 cm. long; petioles slender, tortuous, 5–9 mm. long; leaf-blades oblong-lanceolate to triangular-lanceolate,

thin, 40–65 mm. long, 12–18 mm. wide, broadest near the base, long-acuminate from the middle or below it, broadly cuneate to an acute or obtuse base, or rarely truncate, sharply and irregularly serrate with triangular-subulate teeth interspersed with subulate cilia (about 5 teeth per cm. of margin, 1–1.5 mm. long); lateral veins 4 or 5 pairs, ascending at an angle of 30–45°, the veinlets inconspicuously reticulate; peduncles axillary, slender, curved at the summit, 9–11 cm. long; hypanthium obovoid-pyriform, 10 mm. long, abruptly expanded above the middle, faintly ribbed; sepals erect, subulate-triangular above the dilated base, 4 mm. long, separated by broadly rounded sinuses; corolla pink (or carmine-red), 5 cm. long, the tube greatly contracted to 5 mm. above its base, thence gradually expanded and 11 mm. wide at the throat when pressed, the lobes oblong-triangular, abruptly acuminate; filaments exserted about 4 mm., minutely villous on the ventral side; anther-tube 8 mm. long, sparsely pilose with short white hairs, the two lower anthers penicillate. FIG. 23.

Type, *Pennell & Killip 8033*, collected 2 July 1922, San Antonio to Rio Ortega, Dept. El Cauca, Colombia, altitude 2100–2200 m., and deposited in the herbarium of The New York Botanical Garden. A second collection is *Pennell & Killip 5866*, La Cumbre, Dept. El Valle, alt. 1800–2100 m., 21–25 May 1922. Distinguished from *S. venosus* Gleason by its narrower, long-acuminate leaves; from *S. pyriformis* Zahlbr. by its shorter sepals and its serrate leaves cuneate to the base.

Siphocampylus coronatus n. sp. Stem apparently woody, the whole plant glabrous except the petioles and anthers; stems pale brown, finely striate, leafy, the internodes 15–30 mm. long; petioles slender, frequently tortuous, 4–8 mm. long, minutely villous on the upper side; leaf-blades thin, dark green, ovate-oblong, 5–7.5 cm. long, 2–3 cm. wide, broadest well below the middle, thence gradually tapering to the acute tip, truncate to subcordate and frequently inequilateral at base, sharply and irregularly serrate with triangular-subulate teeth (about 5–6 teeth per cm. of margin, 1–2 mm. long); lateral veins 5–7 pairs, ascending at an angle of about 60°, the veinlets finely reticulate; peduncles axillary, 6–8 cm. long, slender, mostly curved near the summit, ebracteolate; hypanthium obovoid-pyriform, 9 mm. long, 8 mm. wide when pressed; sepals foliaceous, recurved-spreading, oblong-lanceolate, 9–11 mm. long, long-acuminate, veiny, sharply subulate with triangular-subulate teeth; corolla red, 5 cm. long, the tube greatly contracted 5 mm. above the base, and thence gradually expanded to 11 mm. wide at the throat, the lobes oblong-triangular, acute; filaments

glabrous, exserted about 5 mm.; anther-tube dull gray, glabrous except for a very few long white hairs, the two lower anthers penicillate. FIG. 24.

Type, *Pittier 868*, collected Jan. 1906, above Palmira, Dept. El Valle, Colombia, altitude 1200–1600 m., and deposited in the United States National Herbarium. Its nearest relative is apparently *S. megalanthus* Zahlbr., which has similar long, recurved, but linear sepals, and is generally pubescent on its foliage and flowers. Its foliaceous sepals distinguish it at once from the glabrous members of the group with pyriform hypanthium.

Explanation of plate 3

FIGS. 1–7, hypanthium, calyx, and base of corolla, × 1.5, of

1. Centropogon congestus.
2. Centropogon gesnerioides.
3. Centropogon angustus.
4. Centropogon serratus.
5. Centropogon curvatus.
6. Centropogon parvulus.
7. Centropogon pedicellaris.

FIG. 8, pedicel at maturity, × 1.5, of Centropogon pedicellaris.

FIGS. 9–15, hypanthium and calyx, with or without the base of the corolla, × 1.5, of

9. Centropogon ciliatus.
10. Centropogon decemlobus.
11. Centropogon Purdieanus.
12. Centropogon leucophyllus.
13. Centropogon carpinoides.
14. Centropogon griseus.
15. Centropogon Hitchcockii.

FIGS. 16 and 17, single flower, natural size, of

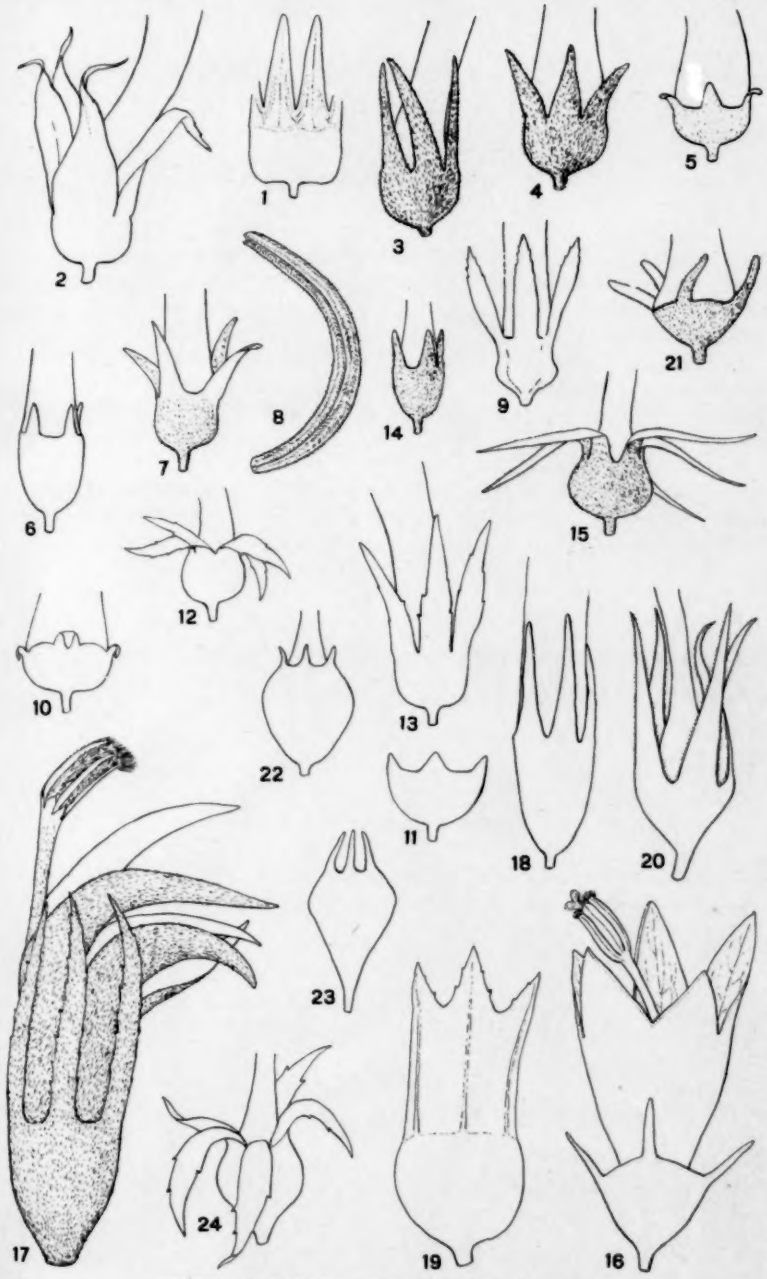
16. Siphocampylus Pennellii.
17. Siphocampylus cylindricus.

FIG. 18, hypanthium, calyx, and base of corolla, natural size, of Siphocampylus stellatus.

FIG. 19, hypanthium and portion of calyx, × 1.5, of Siphocampylus Hazenii.

FIGS. 20–24, hypanthium and calyx, with or without the base of the corolla, × 1.5, of

20. Siphocampylus dentatus.
21. Siphocampylus pilosus.
22. Siphocampylus venosus.
23. Siphocampylus obovoideus.
24. Siphocampylus coronatus.



CENTROPOGON AND SIPHOCAMPYLUS

UNIV. OF MICH.

INDEX TO AMERICAN BOTANICAL LITERATURE
1924

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Reviews, and papers that relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omissions, their kindness will be appreciated.

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